1191-B COUNTER

DIFFERENCE DATA 2

For Type 1191 Counter Instruction Manual, Form 1191-0100C, July 1968. Supersedes 1191-B Difference Data 1.

This difference data sheet updates the manual for use with the 1191-B Counter. Please note the changes listed below and then add this notice to the rear of your manual.

GENERAL

The 1191-B Counter replaces its predecessor, the 1191 Counter, and includes the following changes:

	1191-B	1191
Upper frequency limit	20 MHz, 10-mV rms sensitivity 35 MHz, 100-mV rms sensitivity	20 MHz, 10-mV rms sensitivity ——
Minimum display time	$<1\ \mu s$	$100\ \mu s$
Standby power	Added. Turn POWER on and set DISPLAY TIME control to STAND-BY POWER. Keeps the crystal oven on for maximum stability.	——
PERIOD and TIME INTERVAL Programming	6-mA external current required	50-mA external current required

In addition, a new method of single-period measurements has been added. This method (single period variable clock) not only allows measurements of greater than 10s but also provides a measurement of every period rather than a maximum of every other period as is the case with all other counters and with the normal single-period mode of the 1191-B (PERIOD button pushed, RANGE control set to 1).

For single-period variable-clock measurements, simultaneously push the PERIOD and TIME INTERVAL buttons and connect the signal to INPUT B. Since the display time is subtracted from the measurement, set the DISPLAY TIME control to $<1\ \mu s$ for greatest accuracy.

In general, all references to an upper-frequency limit of 10 MHz should be 35 MHz and all references to a minimum display time of 100 μs should be $<1\ \mu s$. Also make the following changes (noted in bold-face type):

page 2-6 Paragraph 2.5.1: Delete the PRT signal from pin 23 and add the **PCM** signal. Add **PRT** to **pin 47.**

page 2-7 Delete page and add note: **See difference data 2, page 2-7.**

©GENERAL RADIO COMPANY 1969

West Concord, Massachusetts, U.S.A. 01781
Form 0119-0100-2C
May, 1969
ID-8911

page 2-8 Paragraph 2.6.2: Delete last six lines beginning with "The 50 mA sink current . . . . "
Change the first waveform 0-level current from 50 mA to **6 mA** and change the nomenclature from PERIOD, INTERVAL, and COUNT to **ALL OTHERS.**
Delete the second waveform.

page 2-9 Paragraph 2.6.4: Delete paragraph and add note: **See difference data 2, paragraph 2.6.4.**

2.6.4 DISPLAY TIME CONTROL

DRES, DC1 display time inputs (diagram H). To program the DISPLAY TIME control remotely, set the DISPLAY TIME switch to EXT PROG, connect a resistor of the proper value from DRES to ground, and set DC1 to 0 (ground) as shown in the table.

DISPLAY TIME desired	**DRES** *resistance to ground*	**DC1** *(10 μF)*
<1 μs	0Ω (short)	
10 μs	13 kΩ	
100 μs	143 kΩ	
10 ms	0Ω (short)	ground
30 ms	3 kΩ	ground
100 ms	13 kΩ	ground
300 ms	43 kΩ	ground
1 s	143 kΩ	ground
3 s	443 kΩ	ground
10 s	1.44 MΩ	ground

The display time is within approximately 20% of 0.7 of one circuit RC time constant where R = DRES + 1 kΩ and C = 820 pF for display times of <10 ms and 10 μF for display times of 10 ms or greater. Therefore, for display times of <10 ms, DRES = 1740T − 1 and for display times of 10 ms or greater, DRES = 0.143 T − 1 where DRES is in kΩ and display time T is in ms. For example, if a display time of 500 ms is desired, DRES must be (0.143 x 500) −1 or ≈ 70 kΩ.

The DRES and DC1 signals are available at SO950. DRES is at pin 30 and DC1 at pin 13.

page 3-2 Paragraph 3.2.1: Add note to bottom of table: **When the counter is set for single-period variable-clock measurements (both the PERIOD and the INTERVAL buttons pushed) the decimal-point location and symbol are the same as for INTERVAL measurements.**

page 3-8 Paragraph 3.5.1: Add note to DISPLAY TIME control settings: **For changes, see difference data 2, paragraph 3.5.1.**

DISPLAY TIME . . . . <1 μs to 10 s . . . . For automatically initiated measurements.
or SINGLE MEASURE. . For manually initiated measurements.
or STANDBY POWER. . For clock operation only (turn POWER switch on).

Delete the Setting and Display Time columns. Add a new column: **DISPLAY TIME <1 μs, 10 μs, 100 μs, 10 ms, 30 ms, 100ms, 300 ms, 1 s, 3 s, 10 s.**

page 3-11 Paragraph 3.9.2: Delete NOTE (this anomaly has been eliminated in the 1191-B).

page 4-14 Paragraph 4.10: Delete and add note: **See difference data 2, page 4-14.**

page 4-15 Delete page and add note: **See difference data 2, page 4-15.**

page 4-17 Paragraph 4.11.4: The output gate (gate 1) of the block diagram now consists of an **AND gate** and a **NOR gate.** The logic remains the same.

page 4-18 Paragraph 4.11.5: See page 4-17, paragraph 4.11.4 change.
Indicate the FREQUENCY timing diagram moved to paragraph 4.11.6, and replace it with the PERIOD timing diagram.

page 4-19 Paragraph 4.11.6: See page 4-17, paragraph 4.11.4 change.
Indicate the PERIOD timing diagram to be moved to paragraph 4.11.5, and replace it with the FREQUENCY timing diagram.

page 4-20 Paragraph 4.11.7: See page 4-17, paragraph 4.11.4 change.

page 4-21 Paragraph 4.11.8: See page 4-17, paragraph 4.11.4 change.
Add paragraph 4.11.9, **SINGLE PERIOD VARIABLE CLOCK. See difference data 2, page 4-21.**

page 5-2 Paragraph 5.4.2: Change GR part numbers for the following boards:

C Input	1191-472**2**
D Format	1191-476**2**
H Program	1191-477**2**

page 5-8 Paragraph 5.6.1, Equipment required: Change pulse-generator duration characteristics from 300 ns to 200 μs to 300 ns to **350 ms** and change signal generator frequency characteristics from 1 to 20 MHz to 1 to **35 MHz** and amplitude characteristics from 10 to 20 mV to 10 to **100 mV.**

page 5-11 Paragraph 5.6.4, Indication: The first four sentences should read,
AREF must be –0.08 to –0.1**2** Vdc.
AREF must be +0.08 to +0.1**2** Vdc.
BREF must be –0.08 to –0.1**2** Vdc.
BREF must be +0.08 to +0.11 Vdc.

B channel: Change level of 1-MHz generator signal from 10 V rms to **10 mV rms.**

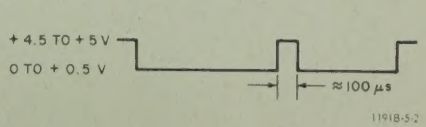
page 5-14 Paragraph MPS3 5.6.8, Display time and Print commands paragraphs: Delete and add note: **See difference data 2, paragraph MPS3 5.6.8.**

Display time. Push FREQUENCY button and set DISPLAY TIME and RANGE as follows:

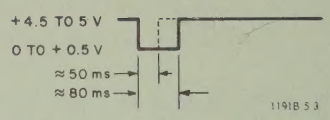
DISPLAY TIME	RANGE	Display time must be as follows
< 1 μs	10^2	<1 μs
10 μs	10^2	8 to 12 μs
100 μs	10^3	80 to 120 μs
10 ms	10^3	7 to 12 ms
30 ms	10^3	24 to 36 ms
100 ms	10^6	80 to 120 ms
300 ms	10^6	240 to 360 ms
1 s	10^6	0.8 to 1.2 s
3 s	10^6	2.4 to 3.6 s
10 s	10^6	8 to 12 s

The PGT signal must be as shown (F21 will be inverted).

Print commands. (PGT checked above). Set DISPLAY TIME to 300 ms, set RANGE to 10^6, and connect scope to SO+ print command (rear panel PROGRAMMING INPUT socket, SO950–17). SO+ must be as shown.



Connect scope to PRT print command (rear panel DATA OUT socket, SO901 –47 on counters with data-output option) and externally trigger pulse generator on negative slope from the same point. Set generator for negative 50-ms pulses, connect output to PCM input (SO901 –23), and set output to OV. Then set output to 5 V. PRT must be as shown by solid line when pulse-generator output is 0 V, and as shown by dashed line when output is 5 V.



page 6-7 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts: C, D, H, C203, C204, C206, C253, and C254.

page 6-8 Add note to bottom of page: ***See difference data 2,** delete the following parts, and add an asterisk near the deletion: C701 through C715.

page 6-9 Add note to bottom of page: ***See difference data 2,** after C904 add *C905, and asterisk the following parts: C925, C926, C930, C931, and CR204.

page 6-10 Add note to bottom of page: ***See difference data 2,** delete the following parts, and add an asterisk near the deletion: CR601 through CR649 and CR701.

page 6-11 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts: CR701 thru CR708, IC102, and IC103.

page 6-12 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts: IC601, IC602, IC603, IC801, IC806, L203, L204, L205, L253, and L254.

page 6-13 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts: Q205 thru Q208.

page 6-14 Add note to bottom of page: ***See difference data 2,** asterisk Q602, delete the following parts and add an asterisk near the deletion: Q701 through Q714.

page 6-15 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts: R215, R217, R220, R221, R225, R227, R256, R257, R277, and R278.

page 6-16 Add note to bottom of page: ***See difference data 2,** and asterisk R502,

page 6-17 Add note to bottom of page: ***See difference data 2,** asterisk R554, delete the following, parts and add an asterisk near the deletion: R602 through R703.

page 6-18 Add note to bottom of page: ***See difference data 2,** delete the following parts and add an asterisk near the deletion: R704 through R738.

page 6-19 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts: R911 through R919.

page 6-20 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts: R961, R962, and R963.

page 6-21 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts: SO951 through SO958.

When replacing T501, include the instrument ID number.

page 6-22 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts:

BENCH CABINET	2	Foot, extruded black neoprene
	2	Screws, 10-32 x 5/16 in. with black nylon washers
RACK CABINET	2	Side pan assemblies
	2	Screws, 10-32 x 5/16 in. with black nylon washers
FRONT PANEL	1	Dress panel
	A and B POLARITY & ATTEN switches (S908, S909)	
	2	Knob assemblies, snap-fit over bushings

page 6-23 Add note to bottom of page: ***See difference data 2,** and asterisk the following parts:

REAR PANEL	2	Insulators, black neoprene
LEFT-SIDE PANEL	4	Slide blocks, black nylon
RIGHT-SIDE PANEL	4	Slide blocks, black nylon

diagram AT Delete page and add note: **See difference data 2, diagram AT.**

diagram AX Delete page and add note: **See difference data 2, diagram AX.**

diagram C Delete page and add note: **See difference data 2, diagram C.**

diagram D Delete page and add note: **See difference data 2, diagram D.**

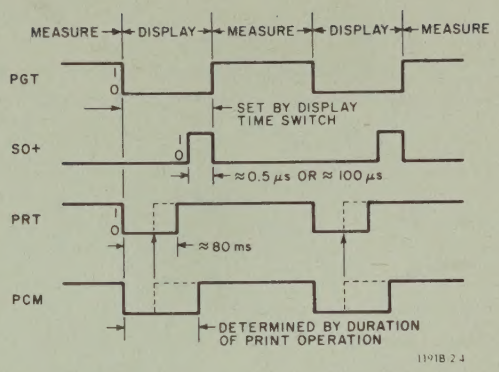
diagram G Delete page and add note: **See difference data 2, diagram G.**

diagram H Delete page and add note: **See difference data 2, diagram H.**

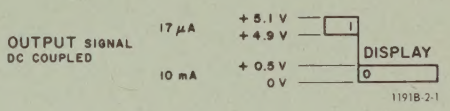
diagram L-1 Delete page and add note: **See difference data 2, diagram L-1.**

2.5.3 PRINT COMMAND SIGNALS

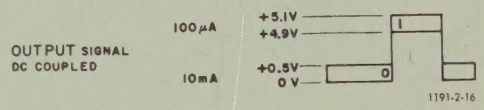
Most data-handling equipment requires a signal to initiate its operation or to synchronize its operation with that of the counter. Three such signals are available from the counter. In addition, an input is provided for synchronization, especially for use with some types of printers. Signals available at SO901 are as follows: PGT, pin 24; PRT, pin 47; PCM, pin 23. Signals available at SO950 are as follows: SO+, pin 17; PRT, pin 34.



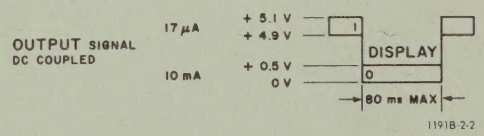
PGT (diagram G). This is a buffered signal at a standard DTL level (data 0 ≈ ground with a 10-mA sink capability, data 1 ≈ +5 V behind 6 kΩ ±20%) that goes to the 0-level at the end of a measurement and to the 1-level after the display time (as set by the DISPLAY TIME control).



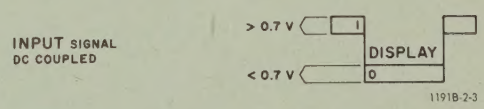
SO+ (diagram H). This is a non buffered, 0.5-µs pulse (with the first three DISPLAY TIME settings) or 100-µs pulse (in the remaining DISPLAY TIME positions), behind 1 kΩ, whose trailing edge resets the counter preparatory to the next measurement. It is available from the PROGRAMMING INPUT socket, SO950 pin 17, and can be used to indicate the counter is ready to make a new measurement.



PRT (diagram H). This is a nonbuffered signal behind 4.7 kΩ that goes to the 0-level at the end of a measurement and to the 1-level 80 ms later, unless forced to the 1-level earlier by the **PCM** input.



PCM (diagram H). The **PCM** signal input is a typical RTL input, with a 4.7 kΩ input resistance with the input voltage high (>0.7 V) and 25 kΩ with the input voltage low (<0.7 V). The signal usually comes from a printer, whose 0-level indicates the device is busy (printing) and whose 1-level indicates the device is ready. When the PCM input returns to the 1-level, it terminates the PRT signal, if it has not already terminated.

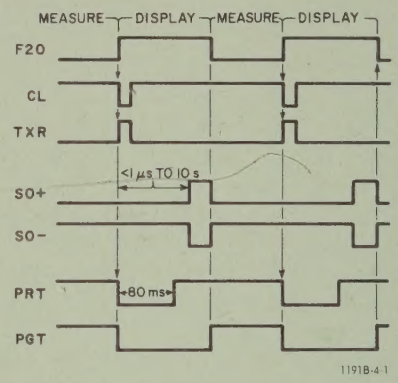


4.10 PROGRAM BOARD H

Diagram H. The program board generates the store signals used for the jam-transfer function, the reset signals used to control display time, and the print-command signals used to initiate external devices.

4.10.1 STORE

CL clear. At the end of a measurement, **F20** from the format board goes to 1 and turns on Q701 in the clear and transfer generator. The negative transition passes through C706, is amplified and stretched by Q706 and Q707, and appears as a negative pulse, CL, at Q707 collector. The 0-level CL signal clears the storage NAND-gate, on the register board (paragraph 4.7.2) of previous data.



TXR transfer. The negative **CL** pulse is inverted by an IC inverter and appears as a positive pulse, TXR, at the output. The 1-level of the TXR pulse reads in new data to the storage NAND-gate and the 0-level of the TXR pulse prevents any further changes in the decade output from affecting the stored data (paragraph 4.7.2).

Storage disable. When the STORAGE-DISABLE switch, S951 on the rear panel, is set to DISABLE, it sets SDIS to 0, which holds off Q706. With Q706 held off, Q707 is held off which sets CL to 0 and, thus, TXR to 1. These levels of CL and TXR cause the storage register to be by-passed, so that the visual register accepts the counted data directly from the counting register (paragraph 4.7.2).

Also, when the COUNT button is pushed, **CN** is set to 0 which causes the same action as when the STORAGE-DISABLE switch is set to DISABLE; i.e., it by-passes the storage register and allows the visual register to accept data directly from the counting register.

4.10.2 DISPLAY TIME

SO+ reset. During a measurement, SO+ is held at 0 by the 0-level F20 signal from the format board, via Q701 through Q705 and the output IC inverter. At the end of a measurement, F20 rises to 1 and turns on Q701, which turns off Q702.

Q702 emitter cannot fall immediately to 0 (ground), however, because of C702 and C703 which have charged to 1 ($\approx$ 15 V). After a period of time, determined by the RC time constant connected to Q702 emitter, the capacitors discharge sufficiently towards 0 to turn off Q703A. When Q703A turns off, it turns on Q703B, which turns off Q704, turns on Q705, and sets SO+ to 1.

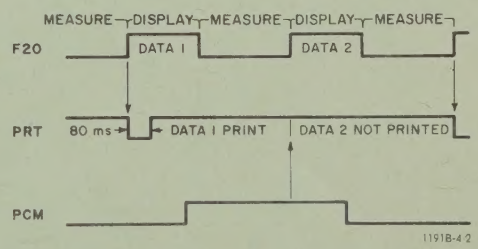
The length of time SO+ remains 1 is determined by the size of the capacitance connected to Q702 emitter and the resistance in its charge path. The capacitance is made up of C702 and C703 and the resistance is the emitter-to-collector resistance of Q702, which is essentially constant. For the first three settings of the DISPLAY TIME control, the 1-level direction of SO+ is $\approx$ 0.5 μs and for the remaining settings it is 100 μs.

SO– reset. The output from Q705 collector is also applied directly to pin 19 as the SO– reset signal, which is inverted with respect to SO+.

Display time control. During the time between the end of a measurement and the occurrence of the SO+ and SO– reset signals, the counter is prevented from starting a new measurement (SO+ enables the timing gate on the program board; if this gate is not enabled, measurements are inhibited; paragraph 4.11.2). This time is determined by the size of the RC network connected to Q702 emitter which, in turn, is controlled by the DISPLAY TIME switch, S907. The DISPLAY TIME switch thus controls a holdoff time between measurements to allow for the observation of the visual register or to allow for the operation of external devices, such as a printer or other piece of data-handling equipment.

4.10.3 PRINT COMMAND

PRT print command. Under initial conditions (during a measurement) Q708 is on and saturated, being held forward biased by R723. Since R724 is about six times the sum of R726 and R727, the voltage at the common emitter of Q708-Q709 is only about 1 V. Q710 is, therefore, normally off and its collector is high. Since PCM is a positive signal when used, Q711 is also normally off. The print cycle is started by applying F20 at the end of a measurement. This positive transition, applied through CR707, momentarily turns Q708 off. Q708's collector voltage rises, turning Q709 and Q710 on. Q709 being on sets the common emitter voltage at about 5 V. C707 requires about 100 ms to charge to this voltage before Q708 can go back on.

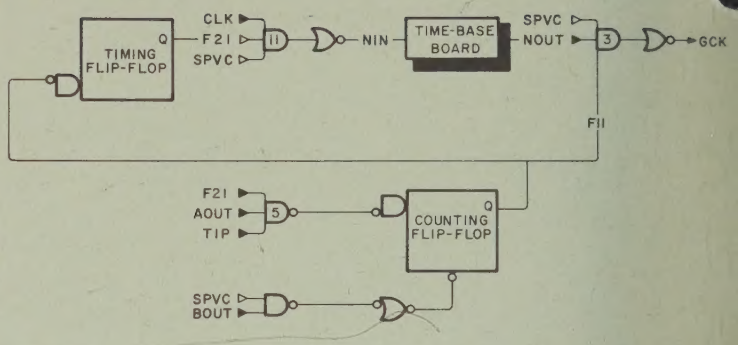


No matter how brief the display interval may be (it can go down to <1 μs), Q710's collector will be low for 100 ms, when Q710's collector again rises to produce a print command.

PCM control signal. If the system is in a closed loop connection, PCM will be applied to hold Q711 on and Q710 off. No new PRT intervals can be produced while PCM is applied.

4.11.9 SINGLE PERIOD VARIABLE CLOCK

Quiescent. Before a measurement, Q of the counting FF is 0, which inhibits all the counting gates including 3. When both the PERIOD and INTERVAL buttons are pushed, it sets the SINGLE PERIOD VARIABLE CLOCK (SPVC) equivalent format level (SPR, A OUT, TIP, PERN, RN and CN) to 1, which enables gates 11 and 5. When the RANGE switch is set to any position except EXT PRO or 1, one of its outputs (TB1 thru TB8) enables a range gate on the time-base board; assume the RANGE switch is set to 10, which allows an N OUT pulse (positive N OUT transition) coincident with the first and tenth N IN pulses (paragraph 4.6.2).



Start. When a shaped input-B event, B OUT from the input board, arrives, it resets the counting flip-flop. Since the DISPLAY TIME is set to <1 μs, the timing flip-flop is complemented (sets it from $\overline{Q}$ to Q) in <1 μs and its output signal, F21, goes through gate 5 and complements the counting flip-flop (sets it from $\overline{Q}$ to Q), which enables gate 3. CLK clock pulses pass through gate 11, emerge as N IN, and are applied to the time-base board, which produces an N OUT pulse. N OUT passes through the already enabled gate 3 and a NOR gate, emerges as GCK, and is counted by the counting register on the register board.

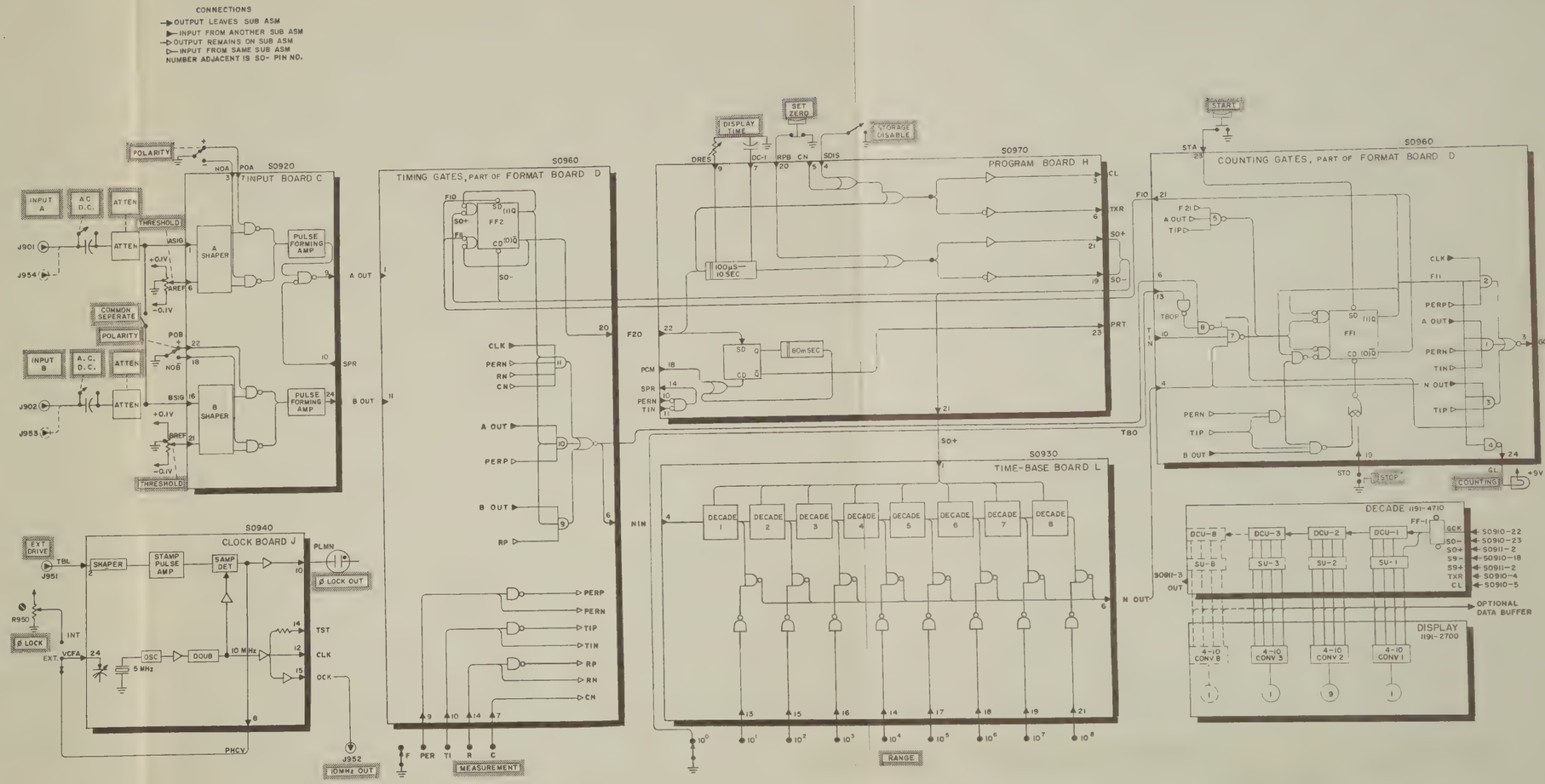
Stop. Each time a shaped input-B event, B OUT, enters the 1191-B the counting flip-flop is reset, inhibiting gate 3 and resetting the timing flip-flop to $\overline{Q}$. When the timing flip-flop is reset, gate 5 is inhibited, blocking out A OUT from the counting flip-flop and terminating the measurement.

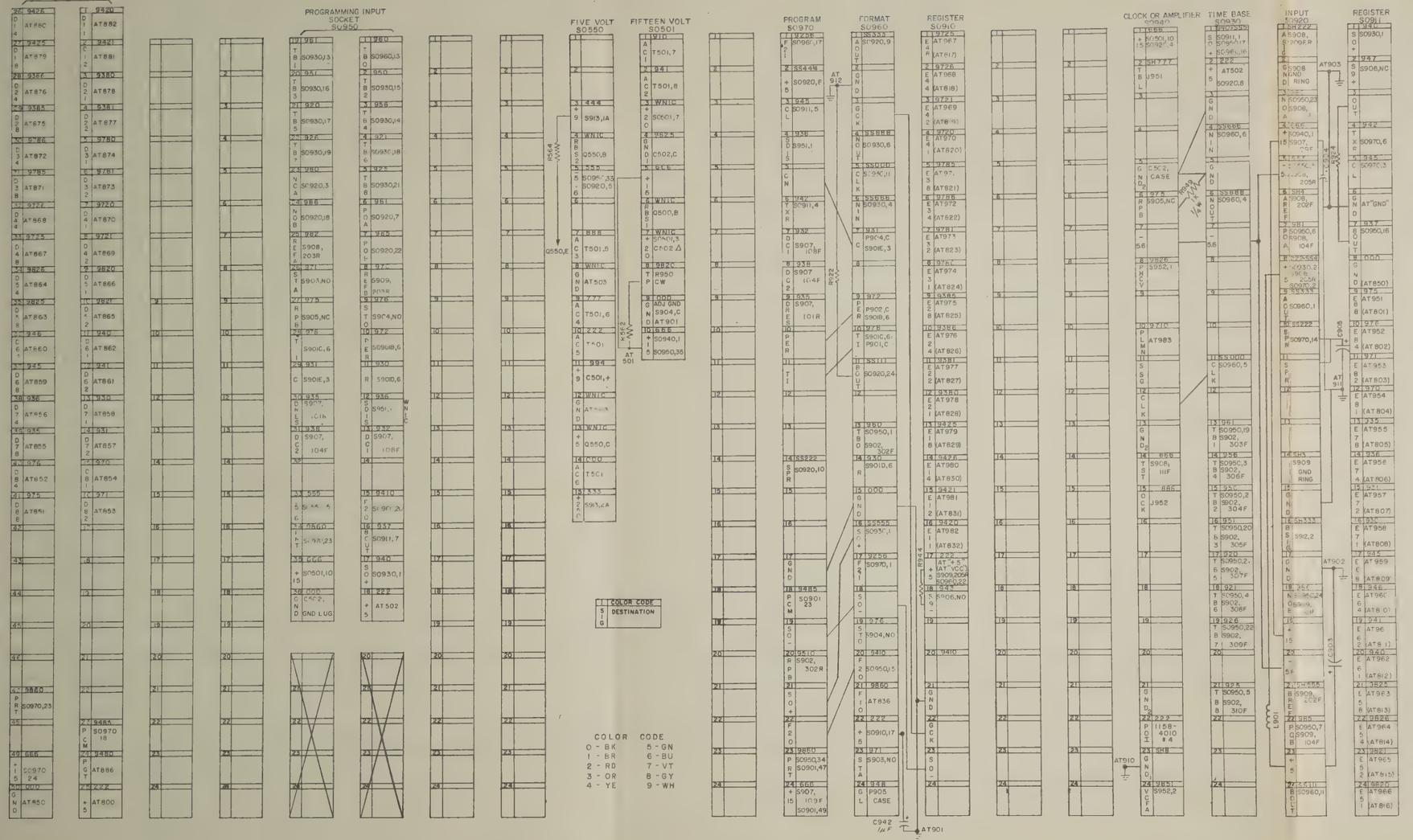
Reference Designation	Description	GR Part No.	Fed. Mfg. Code (see 6.4)	Mfg. Part No.	Fed. Stock No.
C	Input board	1191-4722	24655	1191-4722	
D	Format board	1191-4762	24655	1191-4762	
H	Program board	1191-4772	24655	1191-4772	
C203	Ceramic, 6.8 pF ±5% 500 V	4411-9685	72982	0831003B1G00689J	
C204	Ceramic, 6.8 pF ±5% 500 V	4411-9685	72982	0831003B1G00689J	
C206	Ceramic, 27 pF ±10% 500 V	4404-0278	72982	831, 27 pF ±5%	
C253	Ceramic, 6.8 pF ±5% 500 V	4411-9685	72982	081003B1G00689J	
C254	Ceramic, 6.8 pF ±5% 500 V	4411-9685	72982	081003B1G00689J	
C701	Ceramic, .01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C702	Ceramic, 820 pF ±10% 500 V	4405-1828	72982	801, 820 pF ±10%	
C703	Ceramic, 10 µF ±10% 25 V	4450-5850	56289	109D106X9025C2	
C704	Ceramic, 68 pF ±10% 500 V	4404-0688	72982	831, 68 pF ±10%	
C705	Ceramic, .1 µF +80-20% 200 V	4400-2070	80183	5C13,.1 µF ±20%	5910-083-6445
C706	Ceramic, 100 pF ±10% 500 V	4404-1103	72982	831, 100 pF ±10%	
C707	Electrolytic, 1 µF ±20% 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C708	Ceramic, .001 µF +80-20% 500 V	4404-2109	72982	831, .001 µF +80-20%	5910-983-9994
C709	Electrolytic, 1 µF ±20% 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C710	Ceramic, .01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C711	Ceramic, .01 µF +80-20% 50 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C905	Electrolytic, 1 µF ±10% 35 V	4450-4301	56829	150D105X9035A2	
C925	Ceramic, 20 pF ±5% 500 V	4410-0205	72982	811, 20 pF ±5%	
C926	Ceramic, .0022 µF ±5% 500 V	4406-2225	72982	811, .0022 µF ±5%	5910-899-0668
C930	Ceramic, 20 pF ±5% 500 V	4410-0205	72982	811, 20 pF ±5%	
C931	Ceramic, .0022 µF ±5% 500 V	4406-2225	72892	811, .0022 µF ±5%	5910-899-0668
CR204	Type 1N995	6082-1002	80368	1N995	
CR601 thru CR615	Type 1N995	6082-1002	80368	1N995	
CR616	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR617 thru CR620	Type 1N995	6082-1002	80368	1N995	
CR621	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR701 thru CR708	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR903	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR904	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
IC102	Type SF203 Sylvania	5431-9605	11293	SF203	
IC103	Type DT µL 945 Fairchild	5431-9492	07263	DT µL 945	
IC125	Type SN7490N Texas Instruments	5431-8190	01295	SN7490N	
IC126	Type SN7490N Texas Instruments	5431-8190	01295	SN7490N	
IC127 thru IC132	Type DT µL 945 Fairchild	5431-9492	07263	DT µL 945	
IC133	Type SN7490N Fairchild	5431-8190	01295	SN7490N	
IC601	Type SN74H55N Texas Instruments	5431-8255	01295	SN74H55N	
IC602	Type DT µL 936 Fairchild	5431-9362	07263	DT µL 936	
IC603	Type SN74H60N Texas Instruments	5431-8260	01295	SN74H60N	
IC604	Type SN74H55N Texas Instruments	5431-8255	01295	SN74H55N	
IC605	Type SN74H00N Texas Instruments	5431-8200	01295	SN74H00N	
IC606	Type DT µL 950 Fairchild	5431-9502	07263	DT µL 950	
IC607	Type DT µL 950 Fairchild	5431-9502	07263	DT µL 950	
IC701	Type SN74H40N Texas Instruments	5431-8240	01295	SN74H40N	
IC801 thru IC806	Type DT µL 936 Fairchild	5431-9362	07263	DT µL 936	

Reference Designation	Description	GR Part No.	Fed. Mfg. Code (see 6.4)	Mfg. Part No.	Fed. Stock No.
L203	.68 μH ±10%	4300-0505	99800	1537, .68 μH ±10%	
L204	.68 μH ±10%	4300-0505	99800	1537, .68 μH ±10%	
L205	.68 μH ±10%	4300-0505	99800	1537, .68 μH ±10%	
L253	.68 μH ±10%	4300-0505	99800	1537, .68 μH ±10%	
L254	.68 μH ±10%	4300-0505	99800	1537, .68 μH ±10%	
Q205 thru Q208	Type 2N4258	8210-1136	93916	2N4258	
Q209	Type 2N4275	8210-1126	23342	2N4275	
Q602	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
Q701	Type 2N4275	8210-1126	23342	2N4275	
Q702	Type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q703	Type GK-101	8210-1170	17856	DN259	
Q704	Type 2N4258	8210-1136	93916	2N4258	
Q705	Type 2N4275	8210-1126	23342	2N4275	
Q706	Type 2N4258	8210-1136	93916	2N4258	
Q707 thru Q712	Type 2N4275	8210-1126	23342	2N4275	
Q713	Type 2N3414	8210-1047	24446	2N3414	5961-989-2749
R215	Composition, 30 Ω ±5% 1/4 W	6099-0335	75042	BTS, 30 Ω ±5%	
R217	Composition, 30 Ω ±5% 214 W	6099-0335	75042	BTS, 30 Ω ±5%	
R220	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 Ω ±5%	
R221	Composition, 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R225	Composition, 2 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ ±5%	5905-279-4629
R227	Composition, 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-892-0107
R256	Composition, 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-892-0107
R257	Composition, 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-892-0107
R277	Composition, 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-892-0107
R278	Composition, 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-892-0107
R502	Potentiometer, wire-wound, 2.5 kΩ ±10%	6051-2259	96791	2600 PC, 2.5 Ω ±10%	
R554	Composition, 240 kΩ ±5% 1/2 W	6100-4245	01121	RC20GF244J	5905-279-2521
R602	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R603	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R604	Composition, 4.7 kΩ ±10% 1/4 W	6099-2479	75042	BTS, 4.7 kΩ ±10%	
R605	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R606	Composition, 5.6 kΩ ±10% 1/4 W	6099-2569	75042	BTS, 5.6 kΩ ±10%	
R607	Composition, 6.8 kΩ ±10% 1/4 W	6099-2689	75042	BTS, 6.8 kΩ ±10%	
R608	Composition, 6.8 kΩ ±10% 1/4 W	6099-2689	75042	BTS, 6.8 kΩ ±10%	
R609	Composition, 6.8 kΩ ±10% 1/4 W	6099-2689	75042	BTS, 6.8 kΩ ±10%	
R701	Composition, 1.8 kΩ ±10% 1/4 W	6099-2189	75042	BTS, 1.8 kΩ ±10%	
R702	Composition, 11 kΩ ±5% 1/4 W	6099-3115	75042	BTS, 11 kΩ ±5%	
R703	Composition, 2.7 kΩ ±10% 1/4 W	6099-2279	75042	BTS, 2.7 kΩ ±10%	
R704	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R705	Composition, 220 Ω ±10% 1/4 W	6099-1229	75042	BTS, 220 Ω ±10%	
R706	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R707	Composition, 5.6 kΩ ±10% 1/4 W	6099-2569	75042	BTS, 5.6 kΩ ±10%	
R708	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R709	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R710	Composition, 15 kΩ ±10% 1/4 W	6099-3159	75042	BTS, 15 kΩ ±10%	
R711	Composition, 6.8 kΩ ±5% 1/4 W	6099-2685	75042	BTS, 6.8 kΩ ±5%	5905-686-9997
R712	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R713	Composition, 5.1 kΩ ±5% 1/4 W	6099-2515	75042	BTS, 5.1 kΩ ±5%	5905-279-4623
R714	Composition, 1.2 kΩ ±10% 1/4 W	6099-2129	75042	BTS, 1.2 kΩ ±10%	
R715	Composition, 5.6 kΩ ±10% 1/4 W	6099-2569	75042	BTS, 5.6 kΩ ±10%	
R716	Composition, 560 Ω ±5% 1/4 W	6099-1565	75042	BTS, 560 Ω ±5%	
R717	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R718	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R719	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R720	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R721	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R722	Composition, 2.7 kΩ ±10% 1/4 W	6099-2279	75042	BTS, 2.7 kΩ ±10%	
R723	Composition, 120 kΩ ±5% 1/4 W	6099-4125	75042	BTS, 120 kΩ ±5%	5905-686-9993

ELECTRICAL PARTS LIST (cont)

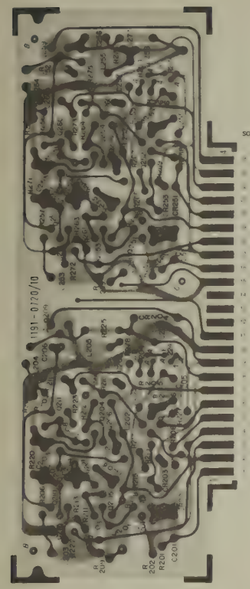
Reference Designation	Description	GR Part No.	Fed. Mfg. Code (see 6.4)	Mfg. Part No.	Fed. Stock No.
R724	Composition, 16 kΩ ±5% 1/4 W	6099-3165	75042	BTS, 16 kΩ ±5%	
R725	Composition, 5.6 kΩ ±10% 1/4 W	6099-2569	75042	BTS, 5.6 kΩ ±10%	
R726	Composition, 2.2 kΩ ±10% 1/4 W	6099-2229	75042	BTS, 2.2 kΩ ±10%	
R727	Composition, 390 Ω ±5% 1/4 W	6099-1395	75042	BTS, 390 Ω ±5%	
R728	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R729	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R730	Composition, 20 kΩ ±5% 1/4 W	6099-3205	75042	BTS, 20 kΩ ±5%	5905-686-3368
R731	Composition, 4.7 kΩ ±10% 1/4 W	6099-2479	75042	BTS, 4.7 kΩ ±10%	
R732	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R733	Composition, 1.8 kΩ ±10% 1/4 W	6099-2189	75042	BTS, 1.8 kΩ ±10%	
R734	Composition, 27 kΩ ±10% 1/4 W	6099-3279	75042	BTS, 27 kΩ ±10%	
R735	Composition, 22 Ω ±10% 1/4 W	6099-0229	75042	BTS, 22 Ω ±10%	
R736	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R737	Composition, 1 kΩ ±10% 1/4 W	6099-2109	75042	BTS, 1 kΩ ±10%	
R738	Composition, 2 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ ±5%	5905-279-4629
R739	Composition, 2 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ ±5%	5905-279-4629
R740	Composition, 10 kΩ ±10% 1/4 W	6099-3109	75042	BTS, 10 kΩ ±10%	
R741	Composition, 5.6 kΩ ±10% 1/4 W	6099-2569	75042	BTS, 5.6 kΩ ±10%	
R742	Composition, 4.7 kΩ ±10% 1/4 W	6099-2479	75042	BTS, 4.7 kΩ ±10%	
R743	Composition, 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ ±5%	5905-682-4100
R911	Composition, 13 kΩ ±5% 1/4 W	6099-3135	75042	BTS, 13 kΩ ±5%	5905-702-4439
R912	Composition, 130 kΩ ±5% 1/4 W	6099-4135	75042	BTS, 130 kΩ ±5%	
R913	Composition, 3 kΩ ±5% 1/4 W	6099-2305	75042	BTS, 3 kΩ ±5%	5905-682-4097
R914	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R915	Composition, 30 kΩ ±5% 1/4 W	6099-3305	75042	BTS, 30 kΩ ±5%	5905-803-2908
R916	Composition, 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R917	Composition, 300 kΩ ±5% 1/4 W	6099-4305	75042	BTS, 300 kΩ ±5%	5905-681-8854
R918	Composition, 1 MΩ ±5% 1/4 W	6099-5105	75042	BTS, 1 MΩ ±5%	
R919	Composition, 120 kΩ ±10% 1/4 W	6099-4129	75042	BTS, 120 kΩ ±10%	
R926	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R927	Composition, 910 kΩ ±5% 1/4 W	6099-4915	75042	BTS, 910 kΩ ±5%	
R928	Composition, 110 kΩ ±5% 1/4 W	6099-4115	75042	BTS, 110 kΩ ±5%	
R930	Composition, 1 MΩ ±5% 1/4 W	6099-5105	75042	BTS, 1 MΩ ±5%	
R931	Composition, 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R932	Composition, 910 kΩ ±5% 1/4 W	6099-4915	75042	BTS, 910 kΩ ±5%	
R933	Composition, 110 kΩ ±5% 1/4 W	6099-4115	75042	BTS, 110 kΩ ±5%	
R961	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%	
R962	Composition, 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%	
R963	Composition, 2.4 kΩ ±5% 1/4 W	6099-2245	75042	BTS, 2.4 kΩ ±5%	5905-683-7724
SO951 thru SO958	Socket	7540-3465	83781	RTS-12	





MECHANICAL PARTS LIST

Quantity	Description	GR Part No.	Fed. Mfg. Code (see 6.4)	Mfg. Part No.	Fed. Stock No.
	BENCH CABINET for bench models:				
2	Foot, extruded black rubber	4171-8010	24655	4171-8010	
2	Screws, 10-32 X 5/16" with white nylon washers, secure rear cover to cabinet	7270-0191	24655	7270-0191	
	RACK CABINET				
2	Side pan assemblies	4174-8040	24655	4174-8040	
2	Screws, 10-32 X 5/16" with white nylon washers, secure rear cover to cabinet	7270-0191	24655	7270-0191	
	FRONT PANEL				
1	Dress panel	1191-1200	24655	1191-1200	
	A and B POLARITY ATTEN. switches (S908, S909):				
2	Knob assemblies, snap-fit over bushings	5520-5331	24655	5520-5331	
	REAR PANEL				
2	Insulators, black neoprene, over fuse holder terminals	5451-3012	24655	5451-3012	
	LEFT-SIDE PANEL				
4	Slide blocks, black nylon	4171-7050	24655	4171-7050	
	RIGHT-SIDE PANEL				
4	Slide blocks, black nylon	4171-7050	24655	4171-7050	



INPUT BOARD C

Part number 1191-4722 (the number that appears on the foil side is not the part number). The dot on the foil at the transistor socket indicates the collector lead.

See paragraph 4.2 for principles.

→ OUTPUT LEAVES SUB ASM
◄ INPUT FROM ANOTHER SUB ASM
→ OUTPUT REMAINS ON SUB ASM
◄ INPUT FROM SAME SUB ASM
(N) SOCKET PIN NUMBER

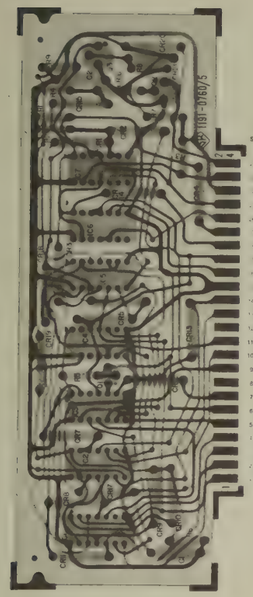
NOTE UNLESS SPECIFIED

1.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K - 1000 OHMS M - 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

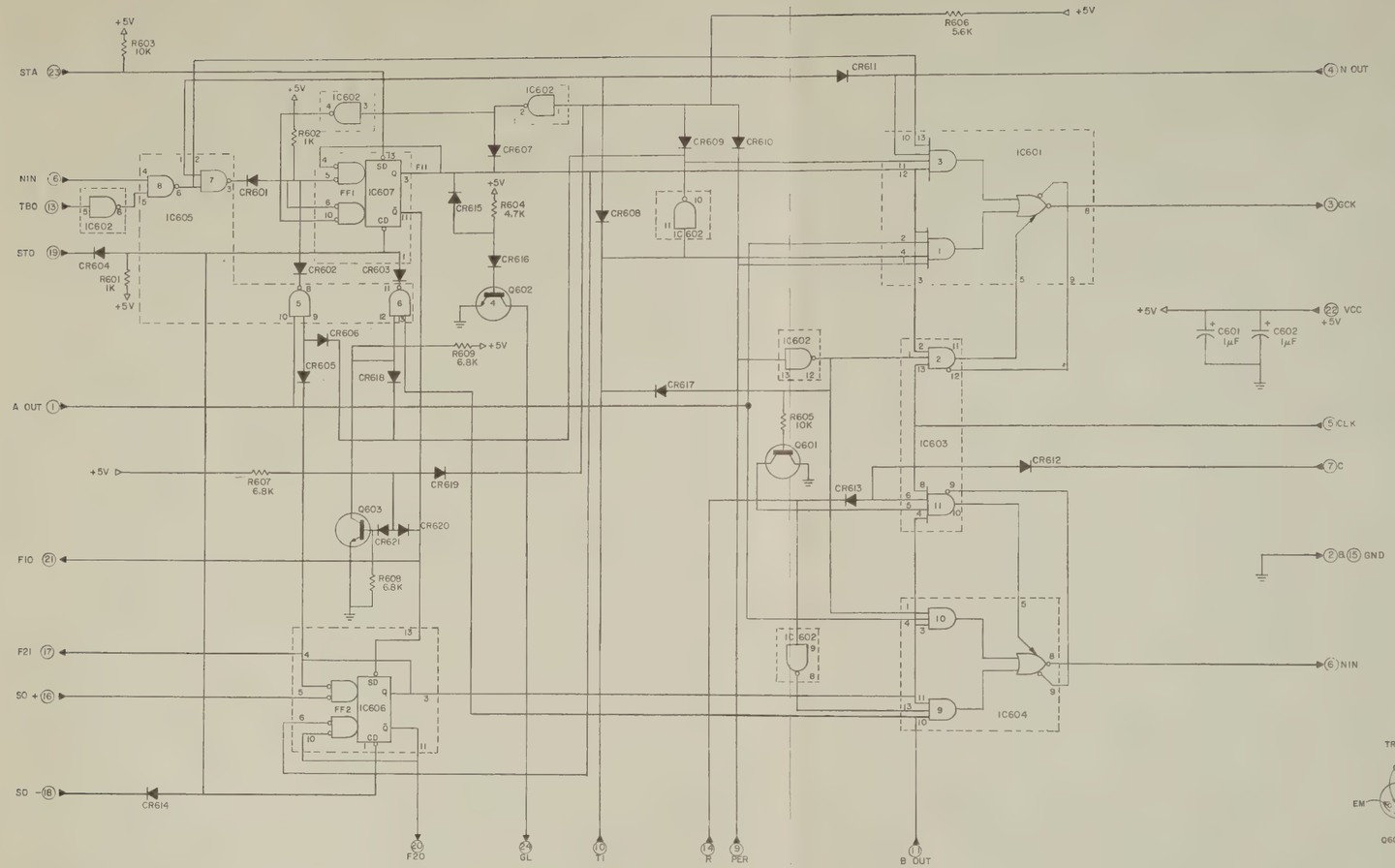
SWITCHES

404F

- Front, Rear.
- Contact: First contact cw from shut is 01.
- Section: Section nearest panel is 1.



	GL	COUNTING LAMP DRIVE
	STA	START
	+5V	SUPPLY VOLTAGE
	F10	COUNTING GATE CONTROL COMPLEMENT
	F20	TIMING GATE CONTROL COMPLEMENT
	STO	STOP
	SO–	RESET
	F21	TIMING GATE CONTROL
	SO+	SET
	GND	CHASSIS GROUND
	R	RATIO PROGRAM
	TBO	RANGE 1 PROGRAM
11	BOUT	B CHANNEL OUTPUT
10	T1	INTERNAL PROGRAM
9	PER	PERIOD PROGRAM
8		
7	C	COUNT PROGRAM
6	NIN	TIMING PULSES
5	CLK	10-MHz CLOCK
4	NOUT	TIMING PULSES SCALED
	GCK	COUNTING PULSES
2	GND	CHASSIS GROUND
1	AOUT	A CHANNEL OUTPUT



TRANSISTORS - BOTTOM VIEW

FORMAT BOARD D

Part number 1191-4762 (the number that appears on the foil side is not the part number). The dot on the foil at the transistor socket indicates the collector lead.

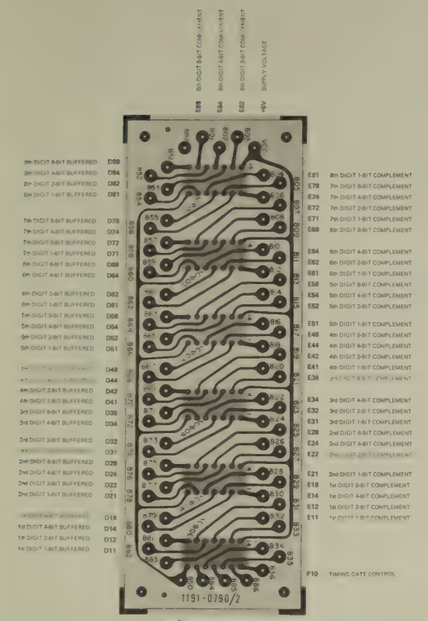
See paragraph 4.11 for principles.

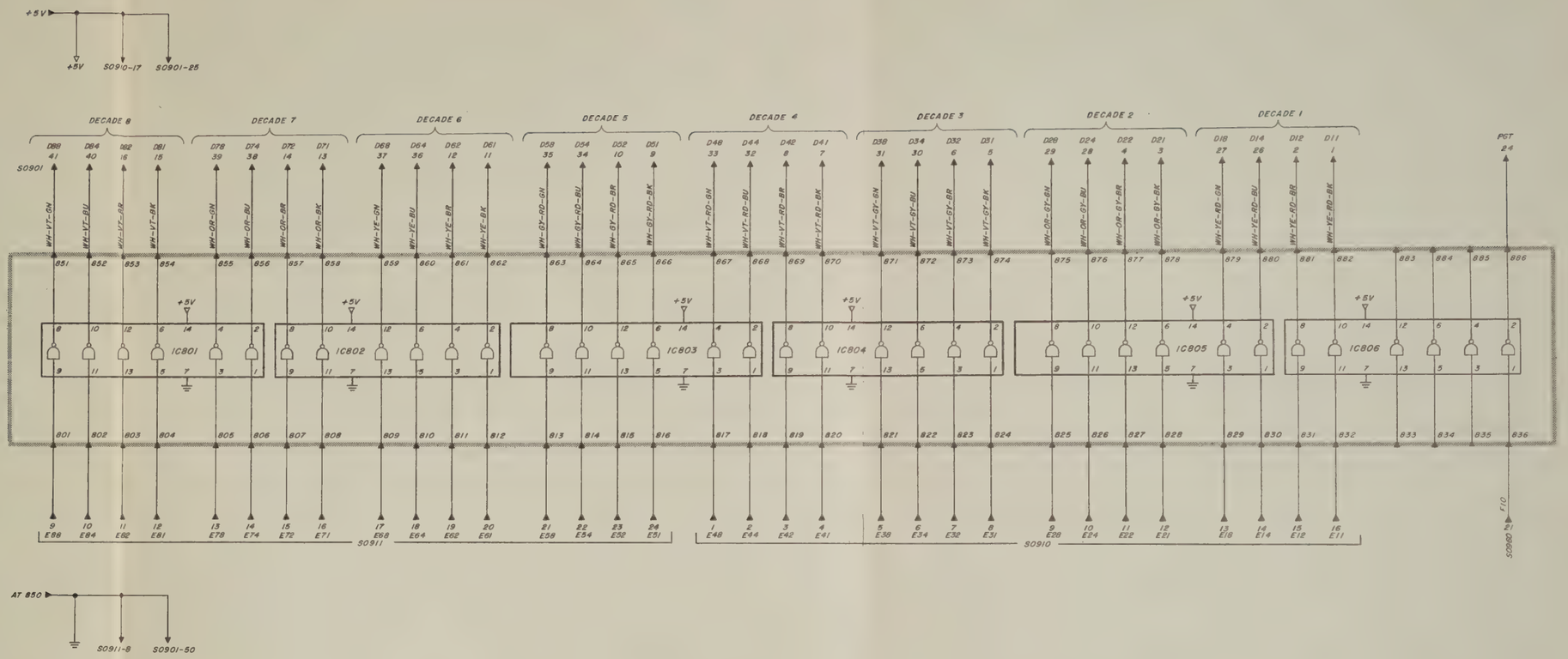
DETAIL PARTS

Capacitor values with no decimal point are pF (10^{-12} F) and with decimal point are μF (10^{-6} F). Resistor values with k are kΩ (10^{3} Ω) and with M are MΩ (10^{6} Ω). ▭ indicates front-panel access. ▭ indicates rear-panel access. ● indicates screwdriver- or alignment-tool operated.

CONNECTIONS

- Output leaves subassembly.
- Input from different subassembly.
- Output remains on subassembly.
- Input from same subassembly.

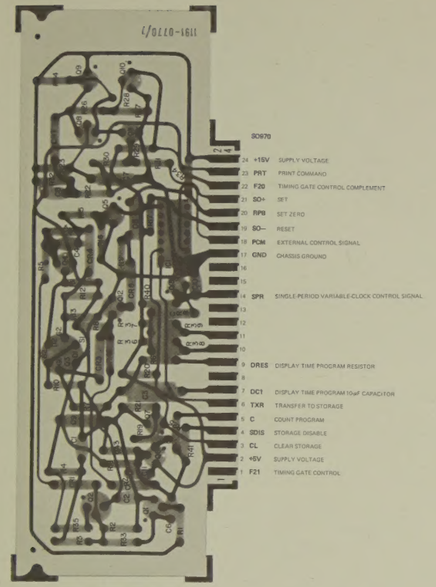




BUFFER CIRCUIT G

Part number 1191-2790 (the number that appears on the foil side is not the part number). The dot on the foil at the transistor socket indicates the collector lead.

See paragraph 4.8 for principles.


1191-0770/F
SO870
24 +15V SUPPLY VOLTAGE
23 PRT PRINT COMMAND
22 F20 TIMING GATE CONTROL COMPLEMENT
21 SO+ SET
20 RPB SET ZERO
19 SO− RESET
18 PCM EXTERNAL CONTROL SIGNAL
17 GND CHASSIS GROUND
4 SPR SINGLE-PERIOD VARIABLE-CLOCK CONTROL SIGNAL
9 DRES DISPLAY TIME PROGRAM RESISTOR
7 DC1 DISPLAY TIME PROGRAM 10uF CAPACITOR
6 TXR TRANSFER TO STORAGE
5 C COUNT PROGRAM
3 SDIS STORAGE DISABLE
2 CL CLEAR STORAGE
1 +5V SUPPLY VOLTAGE
F21 TIMING GATE CONTROL

PROGRAM BOARD H

Part number 1191-4772 (the number that appears on the foil side is not the part number). The dot on the foil at the transistor socket indicates the collector lead.

See paragraph 4.10 for principles.

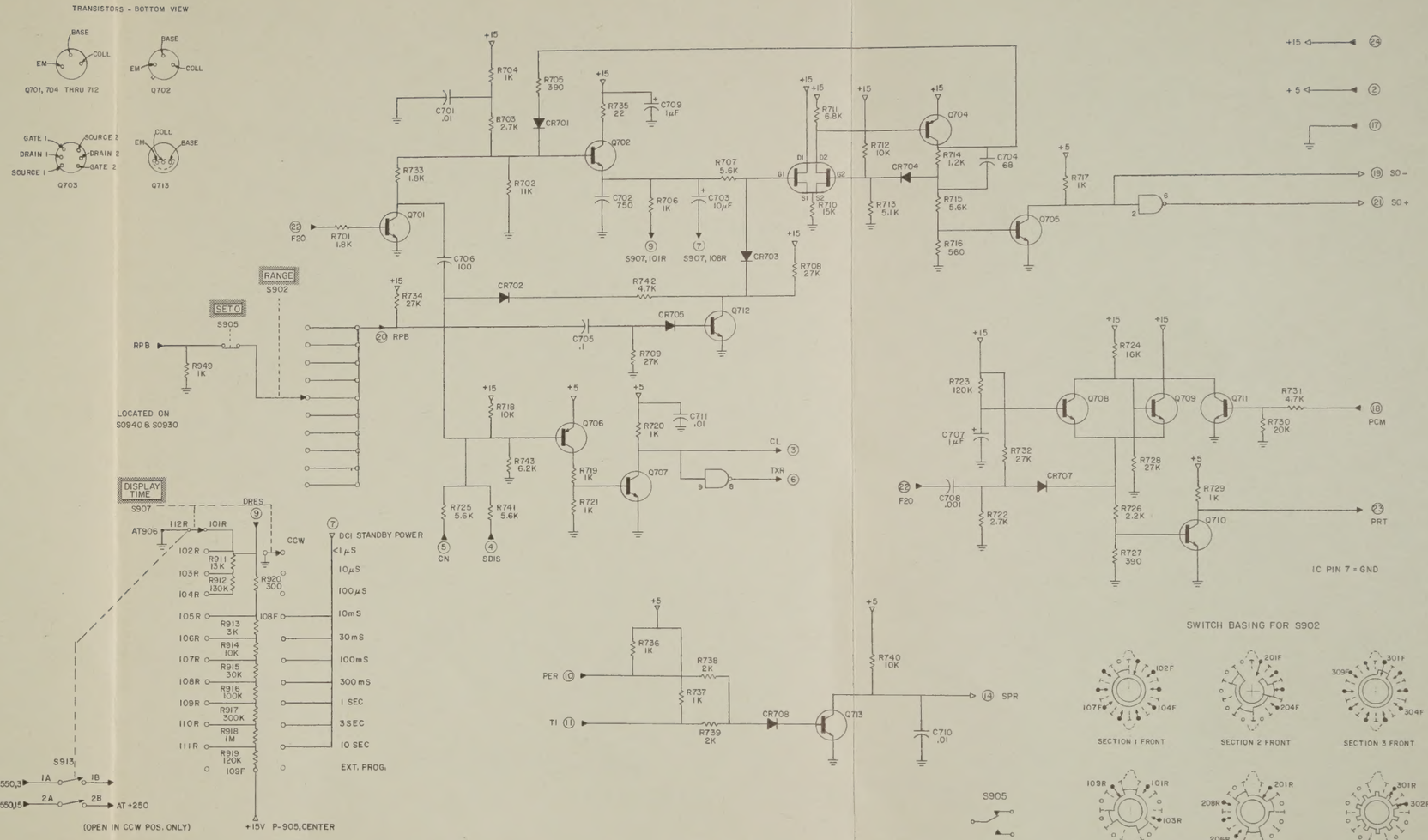
Rotary switch sections are shown as viewed from the panel end of the shaft. The first digit of the contact number refers to the section. The section nearest the panel is 1, the next section back is 2, etc. The next two digits refer to the contact. Contact 01 is the first position clockwise from a strut screw (usually the screw above the locating key), and the other contacts are numbered sequentially (02, 03, 04, etc), proceeding clockwise around the section. A suffix F or R indicates that the contact is on the front or rear of the section, respectively.

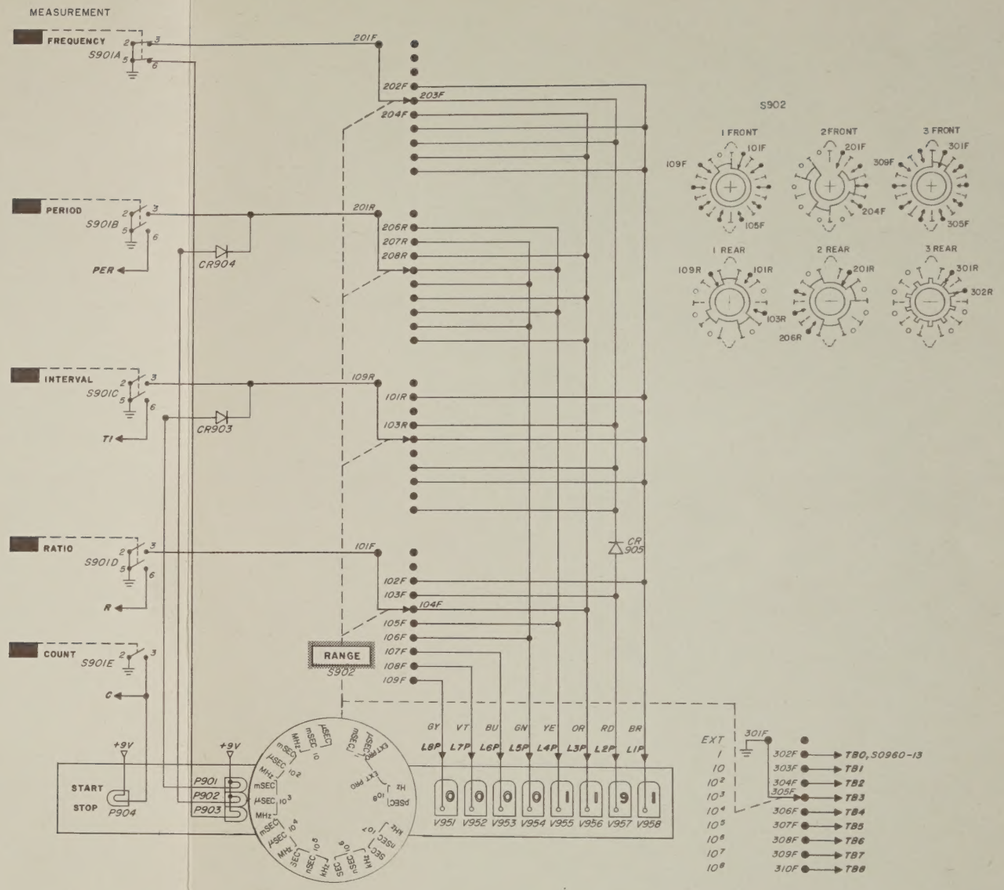
NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ○ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

→ OUTPUT LEAVES SUBASSEMBLY
◄— INPUT FROM DIFFERENT SUBASSEMBLY
—▷ OUTPUT REMAINS ON SUBASSEMBLY
—◁ INPUT FROM SAME SUBASSEMBLY
(N) SOCKET PIN NUMBER

▭ INDICATES FRONT PANEL ACCESS
▭ INDICATES REAR PANEL ACCESS





DETAIL PARTS

Capacitor values with no decimal point are pF (10^{-12} F) and with decimal point are μF (10^{-6} F). Resistor values with k are kΩ (10^{3} Ω) and with M are MΩ (10^{6} Ω). ▭ indicates front-panel access. ▭ indicates rear-panel access. ● indicates screwdriver- or alignment-tool operated.

CONNECTIONS

- Output leaves subassembly.
- Input from different subassembly.
- Output remains on subassembly.
- Input from same subassembly.

SWITCHES

404F

- F: Front, Rear.
- 04: Contact: First contact cw from shut is 01.
- 4: Section: Section nearest panel is 1.

GENERAL RADIO

WEST CONCORD, MASSACHUSETTS 01781
617 369-4400

SALES AND SERVICE

ATLANTA	404 633-6183	DENVER	303 447-9225	ROCHESTER	315 394-2037
*BOSTON	617 646-0500	DETROIT	313 261-1750	PHILADELPHIA	215 646-8030
BRIDGEPORT	203 377-0165	GREENSBORO	919 288-4316	SAN DIEGO	714 232-2727
*CHICAGO	312 992-0800	HARTFORD	203 658-2496	*SAN FRANCISCO	415 948-8233
CLEVELAND	216 886-0150	HOUSTON	713 464-5112	SEATTLE	206 GL4-7545
COCOA BEACH	800 241-5122	HUNTSVILLE	800 241-5122	SYRACUSE	315 454-9323
*DALLAS	214 637-2240	INDIANAPOLIS	317 636-3907	*WASHINGTON, BALTIMORE	301 946-1600
DAYTON	513 434-6979	*LOS ANGELES	213 469-6201		
		*NEW YORK	(NY) 212 964-2722 (NJ) 201 943-3140		

INTERNATIONAL DIVISION

WEST CONCORD, MASSACHUSETTS 01781, USA

AUSTRALIA
Warburton Franki Industries Pty. Ltd.
Sydney, Melbourne, Brisbane, Adelaide

CANADA –
*General Radio Canada Limited
Toronto, Montreal, Ottawa

DEMOCRATIC REPUBLIC OF THE CONGO
Rudolph-Desco Co., Inc.
New York

HONG KONG and MACAU
Gilman & Co., Ltd.
Hong Kong, B.C.C.

INDIA
Motwane Private Limited
Bombay, Calcutta, Lucknow, Kanpur, New Delhi, Bangalore, Madras

JAPAN
Midorlya Electric Co., Ltd.
Tokyo

KOREA
M·C International
San Francisco, Seoul, Korea

MALAYSIA and SINGAPORE
Vanguard Company
Kuala Lumpur, Malaysia

MEXICO
Fredin S.A.
Mexico, D.F.

NEW ZEALAND
W. & K. McLean Limited
Auckland

PAKISTAN
Pakland Corporation
Karachi

PHILIPPINES
T. J. Wolff & Company
Makati, Rizal

PORTUGAL and SPAIN
Ad. Auriema, Inc.
New York, Madrid, Lisbon

REPUBLIC OF SOUTH AFRICA
G. H. Langler & Co., Ltd.
Johannesburg

SOUTH and CENTRAL AMERICA
Ad. Auriema, Inc.
New York

TAIWAN
Heighten Scientific Co., Ltd.
Taipei

THAILAND
G. Simon Radio Company Ltd.
Bangkok

TURKEY
Mevag Engineering, Trading and Industrial Corporation
Istanbul

*GENERAL RADIO COMPANY (OVERSEAS)

Helenastrasse 3, CH-8034, Zürich 34, Switzerland

AUSTRIA
Dipl. Ing. Peter Marchetti
Wien

BELGIUM
Groenpol-Belgique S. A.
Bruxelles

DENMARK
Semler & Matthiassen
København Ø

EIRE
General Radio Company (Overseas)
General Radio Company (U.K.) Limited

FINLAND
Into O/Y
Helsinki

FRANCE
General Radio France
Paris, Lyon

GERMANY
General Radio GmbH
München
Norddeutsche Vertretung
Dr. Ing. Nüsslein
Wedel

GREECE
Marios Dalleggio
Athens

ISRAEL
Eastronics Ltd.
Tel Aviv

ITALY
Ing. S. & Dr. Guido Belotti
Milano, Genova, Roma, Napoli

NETHERLANDS
Groenpol Groep Verkoop
Amsterdam

NORWAY
Gustav A. Ring A/S
Oslo

SWEDEN
Firma Johan Lagercrantz KB
Solna

SWITZERLAND
Seyffer & Co. AG
Zürich

UNITED KINGDOM
*General Radio Company (U.K.) Limited
Bourne End, Buckinghamshire

YUGOSLAVIA
Sanford de Brun
Wien, Österreich

*Repair services are available at these offices.

PRINTED IN U.S.A.